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ABSTRACT

Adverse effects of material rewards on Wechsler subscale performance may be the result of a reward-produced developmental regression. To further explore that idea through replicating earlier findings with adults, and to extend the enquiry to children, selected Wechsler subscales were administered to 32 subjects at each of three ages (5, 10, and 18 years) under either reward or nonreward conditions. Subscales were chosen to represent both algorithmic and heuristic types of tasks. Reward and nonreward groups (eight males and eight females per group at each age) were matched initially on age and ability. For adults, consistent with earlier findings, reward had an adverse effect on performance on the heuristic subscales and tended to facilitate performance on the algorithmic subscales. However, rewards generally had no effect at the fourth grade level and a reverse effect at the nursery school level, i.e., rewards facilitated heuristic and hampered algorithmic performance. These same trends were evident at both higher- and lower-ability levels, assessed via median split, except that at the college level, reward facilitation of algorithmic performance occurred only at the lower ability level, and detrimental effects of reward on heuristic performance were more pronounced at the higher ability level. Also, at the fourth grade, reward had an adverse effect on the algorithmic subscale performance of higher ability subjects. These complex findings appeared to be more consistent with an explanation based on developmental regression than on any available alternative mechanism. (Author)

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Running head: Developmental Effects of Reward on Wechsler Subscales

Abstract

The authors recently proposed that adverse effects of material rewards on Wechsler subscale performance may be the result of a reward-produced developmental regression. This study further explored that idea through an attempt to replicate earlier findings with adults and extend the enquiry to children. Selected Wechsler subscales were administered to 32 subjects at each of 3 ages (5, 10, and 18 years) under either reward or nonreward conditions. Subscales were chosen to represent both algorithmic and heuristic types of tasks. Reward and nonreward groups (8 males and 8 females per group at each age) were matched initially on age and ability. For adults, consistent with earlier findings, reward had an adverse effect on performance on the heuristic subscales and tended to facilitate performance on the algorithmic subscales. However, rewards generally had no effect at the fourth grade level and a reverse effect at the nursery school level, i.e., rewards facilitated heuristic and hampered algorithmic performance. These same trends were evident at both higher- and lower-ability levels, assessed via median split, except that at the college level, reward facilitation of algorithmic performance occurred only at the lower ability level, and detrimental effects of reward on heuristic performance were more pronounced at the higher ability level. Also, at the fourth grade, reward had an adverse effect on the algorithmic subscale performance of higher ability subjects. These complex findings appeared to be more consistent with an explaination based on developmental regression than on any available alternative mechanism.

A Developmental Analysis of the Effects of Reward on Selected Wechsler Subscales

A detrimental effect of material rewards on human performance has been reported frequently in recent years (for some early work, see McCullers & Martin, 1971; Miller & Estes, 1961; Spence and Segner, 1967; For more recent work emphasizing social motivation, see de Charms & Muir, 1978; Deci, 1975; Lepper & Greene, 1978). At first, investigators in this area, and others, found it difficult to believe that rewards could adversely affect performance. Within the past ten years or so, however, there has been a growing conviction (and body of evidence to support it) that the phenomenon of a detrimental effect of reward on performance is genuine. During this time, several alternatives have been proposed to account for this perhaps surprising finding. Among these are (a) the hypothesis that rewards may distract the subject's attention from the task (Spence, 1970), (b) the idea that extrinsic incentives can undermine intrinsic motivation (e.g., Lepper, Greene, & Nisbett, 1973), and (c) the view that the critical factors are the subject's initial perception of task attractiveness in combination with the demands of the task itself (McGraw, 1978).

The present authors have recently suggested yet another interpretation, that of developmental regression (Fabes, Moran, & McCullers, 1981). According to this view, rewards have their adverse effects on performance through a primitivation of psychological functioning. Regression is an old concept, of course, that has seen service in the formulations of several developmental theorists (e.g., Lewin, 1946; Werner, 1948). It has not received much attention in recent years, however, and certainly none in the present context. Nevertheless, regression appeared to offer a viable mechanism for explaining the effects of reward on the performance of university undergraduates on selected subscales of the Wechsler Adult Intelligence Scale (WAIS).

Fabes, Moran, and McCullers (1981) presented six subscales of the WAIS under either standard nonreward or one of three reward (contingent, noncontingent, o social competition) conditions. From the perspective of McGraw's[1] (1978) model, three of these subscales (Information, Digit Symbol, and Picture Completion) were considered to be algorithmic in nature, and three (Block Design, Picture Arrangement, and Object Assembly) heuristic in nature. No significant differences were observed between the three reward groups on either the algorithmic or heuristic subscales. Also, there were no significant differences in performance between reward and nonreward subjects on the algorithmic subscales. However, the nonreward subjects performed significantly better than subjects in each of the three reward groups on the heuristic subscales.

The observed reward-nonreward difference was found to be due to a differential error rate, nonreward subjects making significantly fewer errors than reward subjects, rather than the amount of time subjects spent on the items. If nonreward subjects had made fewer errors on both types of tasks (algorithmic and heuristic), it might have been argued that rewards merely disrupt performance in general, as other investigators have shown. However, the reward-nonreward differences were confined to the heuristic subscales. Given that the subjects were initially matched on age, sex, and IQ, and that IQ scores are generally considered to be resistant to change, the poorer performance of reward subjects, as compared to nonreward subjects, could be viewed as a lower level of intellectual functioning, i.e., a level that normally would have been expected of less mature subjects under nonreward. From this perspective, the poorer performance of reward subjects could be viewed as the consequence of reward-produced regression. The finding that reward-nonreward differences were confined to the heuristic subscales, which appear to require a higher and more abstract level of functioning, would be consistent with a developmental regression interpretation and difficult to

explain in terms of other available theoretical alternatives.

Because of the novelty of this interpretation, and the importance of its implications, it seemed important to attempt to verify the findings of Fabes, Moran and McCullers through replication. The central purpose of the present study was to attempt that replication, and to extend the enquiry to younger subjects. Given that regression is a developmental phenomenon, and given the initial findings that reward did not adversely affect performance on the algorithmic subscales, it might be argued that any observed regression effect should become progressively less apparent at each successively earlier stage of development. A secondary purpose of the study was to further explore the McGraw model (1978) model within a developmental framework.

Method

Subjects and Design

The subjects were preschool children from a university laboratory school, fourth-grade public school children, and university undergraduates from an introductory psychology course. From an initial sample of 48 adults, 46 fourth-graders, and 44 nursery school children, a final sample of 96 subjects were selected to yield 16 reward (8 male and 8 female) and 16 nonreward (8 male and 8 female) at each age level, with reward and nonreward groups closely matched on age and initial ability. All foreign students and students who had recently undergone intelligence testing or were scheduled to be tested in the near future were excluded. In addition, one five-year-old refused to participate.

Materials

Subscales of the Wechsler tests (i.e., the Wechsler Adult Intelligence Scale (WAIS) for university students, the Wechsler Intelligence Scale for Children -- Revised (WISC-R) for fourth graders, and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) for nursery school children) were used both to assess

initial ability and for the experimental tasks. The general rationale for employing Wechsler subscales as experimental tasks was presented in the earlier study (Fabes, Moran, & McCullers, 1981).

Pretest measures. At all three age levels, the Picture Completion (PC) and Vocabulary (V) subscales were used to assess initial ability and for matching purposes. Research on short forms of the WAIS (Maxwell, 1957) has shown this pair of subscales to be one of the best duads for predicting Full Scale IQ scores (r = .914).

Initial ability matching yielded mean scores for male and female reward subjects and male and female nonreward subjects that differed by less than two scaled score points at each age level. The four means ranged from 24.25 to 24.75 for nursery school children, and 21.63 to 23.00 for elementary school children, and from 20.88 to 21.62 for college students. The groups were also matched for age at each level. The four means (male and female reward subjects and male and female nonreward subjects) ranged from 4.80 to 4.99 years for the nursery school children, from 9.84 to 10.12 years for the fourth graders, and from 18.77 to 19.14 years for the college students. An analysis of variance confirmed that there were no significant differences between the reward and nonreward groups or between the sexes on the matching variables of initial ability and age.

Experimental Measures. Six additional Wechsler subscales were selected for use as the experimental tasks. The WAIS subscales in the order they were administered were: Information (I), Similarities (S), Digit Symbol (DS), Block Design (BD), Arithmetic (A), and Object Assemby (OA). From the perspective of McGraw's (1978) model, three subscales were identified as being algorithmic (I, DS, and A), and three as being heuristic in nature (S, BD, and OA). Thus, the order of presentation allowed for algorithmic and heuristic tasks to be presented in alternating fashion.

The order of presentation was the same for the children as for the adults, and the same subscales were used so far as the test materials would permit: For the nursery school children, Geometric Design (GD) replaced OA, and Animal House (AH) replaced DS; at the elementary school level, DS is called Coding (C).

Procedure and Incentive Materials

All subscales were administered individually by either a male or a female graduate student familiar with Wechsler testing procedures. Instructions and procedures followed those prescribed in the appropriate Wechsler manuals (Wechsler, 1955, 1967, 1974). The session consisted of two parts, initial ability testing and the experiment proper. The pretest measures were administered under standard, nonreward conditions. Depending on condition, the experimental subscales were administered under either standard or reward conditions. All subjects were encouraged to do their best. In addition, reward subjects were also told that they would receive a "prize" if they "did well enough on this part".

Reward subjects were aware of the nature of the prizes prior to task engagement. For college students, a monetary incentive of two dollars ($2.00) was used. Nursery and elementary school children were allowed to select a prize in advance from an assortment of books, toys, and games. All reward subjects received a prize, regardless of performance. Rewards were delivered to the university students at the end of the session, and to the children at the conclusion of the study. Nonreward children participated prior to children in the reward group to avoid communication about rewards to nonreward children. To avoid possible injured feelings, in any case where nonreward children could have known that some children were being given rewards, rewards were also provided to the nonreward children at the conclusion of the study for having participated.

Due to the length of time required (40 to 50 minutes) a few preschool children could not be tested in a single session. The WPPSI (Wechsler, 1967)

manual makes note of this problem and indicates that standardization procedures and data take this into account. In the present study, some children were ready to continue after a short break (approximately 15 minutes), for some the session had to be continued the next day, and one child refused to continue. These interruptions and gaps in the testing session occurred with approximately equal frequency in the reward and nonreward groups (3 and 4 children respectively).

Results

Relationship between Initial Ability and Performance

There was a significant overall correlation between pretest scores (sum of the scaled scores for PC and V) and task scores (sum of the scaled scores for the six experimental subscales), $r = .45$, $p < .001$. However, the administration of reward appeared to profoundly affect the correlation between initial ability and task performance. At each age level, the correlation between pretest scores and task scores was lower in the reward than in the nonreward group. The respective correlations for the nonreward and reward groups were .69 and .54 for adults, and .75 and .51 for fourth graders, and .38 and .11 for the preschool children. The correlations between scores on the pretest and on the algorithmic subscales appeared to be most affected by reward. For the algorithmic tasks (A, I, DS or C or AH), the correlation with the pretest scores was highly significant under nonreward, $r = .63$, $p < .001$, but nearly nonexistent under reward conditions, $r = .14$. Fisher's r to z transformation indicated that the difference between these correlation coefficients was significant, $z = 3.21$, $p < .0005$.

Reward Effects

The mean scaled scores for the six task subscales are presented separately for each age level and reward/nonreward condition in Table 1. Inspection of Table 1

Insert Table 1 about here

indicates that reward effects were present and that these varied with subscale and age level. In general, reward did not significantly affect performance at the elementary school level. Reward did have significant effects at the nursery school and college levels, but in opposite directions.

For college students, reward tended to hinder performance on the heuristic subscales and facilitate performance on the algorithmic subscales. Tukey tests revealed that this trend was significant, q (30) = 3.51, $p < .05$, only in the case of the heuristic tasks.

Although there were no significant differences in time spent on task items, rewarded adults made significantly more errors than nonrewarded adults on the heuristic tasks, F (1, 24) = 4.26, $p < .05$. On the DS subscale, an algorithmic task, reward subjects made significantly fewer errors than nonreward subjects, q (30) = 2.96, $p < .05$.

In the case of nursery school children, the effect of reward on the algorithmic and heuristic tasks was reversed. A significant interaction was obtained between reward and type of task, F (1, 24) = 5.45, $p < .03$, but the means indicated that reward facilitated heuristic performance and hampered performance on the algorithmic tasks (See Table 1).

The Importance of Initial Ability

Although reward and nonreward groups at each age level were matched on initial ability, the mean for nursery school children was higher than the means at the other two age levels (24.47, 22.40, 21.12, for the 5-, 10-, and 18-year-olds respectively). Because of the potential importance of ability level, the data were further analyzed in terms of this variable.

A higher and a lower ability subgroup were formed at each age level by means of a median split. The means of the two subgroups produced in this manner were 19.94 and 22.31 at the adult level, 20.25 and 24.56 at the fourth-grade level, and 22.31 and 26.62 at the preschool level. This median-split procedure produced subgroups that differed significantly in initial ability at each age level, $p < .001$ in all cases.

In order to examine the relationship between ability and performance on the six experimental subscales, mean scaled scores were computed for the two ability levels within each age X level condition (reward vs. nonreward) X type of task (algorithmic vs. heuristic) combination. These data are presented in Table 2. In Table 2, the scores for the two types of task were obtained by summing the

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Insert Table 2 about here

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scaled scores for the three algorithmic subscales (I, DS, and A) and the three heuristic subscales (S, BD, and OA). A repeated measures analysis of variance revealed no significant differences as a function of initial ability at the nursery school level. At the two older age levels, however, subjects in the higher ability group performed significantly better than subjects in the lower ability group, F (1, 28) = 8.09, $p < .01$ for adults and F (1, 28) = 5.44, $p < .03$ for fourth graders.

Analysis of the elementary school data revealed a significant Task X Condition X Ability interaction, F (1, 28) = 4.47, $p < .05$. As may be seen in Table 2, reward had little effect on heuristic tasks regardless of ability level. On the algorithmic tasks, however, reward produced a performance decrement in the higher ability subjects, a finding consistent with those obtained with nursery school and college students.

Analysis of the college data revealed a significant Condition X Ability interaction, F (1, 28) = 4.50, p <.05, and a near significant Task X Condition X Ability interaction F (1, 28) = 4.05, p <.06. Table 2 shows the nature of these interactions. High ability subjects showed a decrement due to reward on the algorithmic tasks and an even greater decrement on the heuristic tasks. The lower ability subjects, on the other hand, showed a slight and nonsignificant decrement on the heuristic tasks and a significant reward facilitation on the algorithmic tasks, q (28) = 4.88, p <.01.

Sex Effects

At the nursery school level, females scored higher than males on all subscales, F (1, 24) = 6.31, p <.02. With adults, there was a significant Sex X Subscale interaction, F (5, 120) = 4.90, p <.001, resulting primarily from better performance by females on the DS subscale, q (30) = 4.69, p <.01, and slightly better performance by males on the A subscale, q (30) = 2.78, p <.10.

There was an overall effect of examiner, F (1, 72) = 5.83, p< .02, and this was most pronounced at the nursery school level, F (1, 24) = 4.49, p <.05. The subjects tested by the female examiner scored higher overall than subjects tested by the male examiner. A Reward X Examiner interaction was also found at the nursery school level, F (1, 24) = 5.18, p <.04. This interaction was the result of a reward facilitation on the heuristic tasks that occurred to a greater extent in the subjects tested by the female examiner and a detrimental effect of reward that occurred more in the subjects tested by the male examiner.

Discussion

The present results provide further evidence that a relatively modest material reward can have an adverse effect on intelligence test performance. This finding in itself has some important implications concerning the use of

rewards in intelligence testing. Some investigators (e.g., O'Conner & Weiss, 1974) have argued for the use of extrinsic incentives as a way to equalize motivational differences between subjects in the assessment of intelligence. Apart from being a deviation from standardized procedure, it would now appear that the use of rewards can directly affect test performance. Furthermore, reward effects are not uniform across the test as a whole. As found in our previous study (Fabes, Moran, & McCullers, 1981), rewards had no significant effect on overall performance but showed differential effects on the two broad categories of subscales (algorithmic and heuristic).

The adult data replicated the central finding of our previous study in showing that reward's detrimental effects were confined to the heuristic subscales. Indeed, consistent with McGraw's (1978) predictions, there was a (nonsignificant) tendency for reward to facilitate performance on the algorithmic subscales. The adult data, thus, were generally consistent with McGraw's model, as well as with the regression interpretation. The logic of the regression interpretation was summarized in the introduction and in the earlier study (Fabes, Moran, & McCullers, 1981).

Perhaps the more interesting findings of the present study were those related to developmental and individual differences. The effects of reward on performance varied dramatically as a function of age and ability. Rewards had no effect on performance on either type of subscale (algorithmic or heuristic) at the fourth grade level, which might suggest that there is a minimum level of development below which regression effects do not occur or are not detectable. However, at the nursery school level, rewards enhanced performance on the heuristic subscales and impaired performance on the algorithmic subscales.

When ability level is taken into consideration, the situation becomes

further complicated. It is important to remember (a) that "higher" and "lower" ability levels are in reference to sample means at each age level and not to high and low ability in terms of test norms (in this latter sense, the ability subgroups might have been more properly labeled "higher" and "average"), (b) that sample means were not equivalent across age levels, and (c) that significant differences in performance as a function of ability subgroup were not obtained at the youngest level. Given these considerations, the data indicate that at the lower ability level rewards led to poorer performance on the heuristic subscales at all ages. On the other hand, at the lower ability level, rewards had no effect on the performance of fourth graders but led to a significant facilitation in adults on the algorithmic subscales. At the higher ability level, rewards produced performance decrements on the algorithmic subscales at all ages. On the heuristic subscales, at higher ability level, reward facilitated performance in young children, had no effect on fourth graders, and impaired performance in adults.

There is no obvious simple and straightforward explanation of these results. The theoretical models that base explanations of reward effects on changes in intrinsic motivation, as well as McGraw's two-factor model, as these models now stand, would not seem to offer much help in accounting for the present data. Perhaps this is because the models were not intended to be used in the present context, and because, as yet, ability and developmental parameters have not been incorporated into these models.

Does the regression interpretation fare any better? The best opportunities to observe regression effects logically should be found in those situations where the greatest shift from advanced to primitive functioning/requirements can occur. In terms of age, this means that regression effects should be greater

at higher levels of developmental maturity, i.e., greatest with college students and least with nursery school children. In terms of task, regression effects should be greater on tasks requiring higher levels of original, symbolic functioning, i.e., greater on heuristic than on algorithmic tasks. In terms of ability, regression effects should be greater at higher levels of ability, i.e., greater at the higher than at the lower ability level.

By and large, the data fit these expected trends rather well. The glaring exception occurs in the nursery school data where rewards led to poorer performance on algorithmic and better performance on heuristic tasks. The simplest way to handle these troublesome data would be to dismiss them as an artifact of task, procedure, and/or subject sampling. Indeed, necessarily, there are important differences in content and procedure between comparable subscales at the three developmental levels. Also, Sex and Examiner effects were more pronounced at the nursery school level. And, finally, the present sample of nursery school children tended to contain only children of higher ability. There is no way to tell whether the present data were affected by these factors, or to what degree.

Nevertheless, a number of recent studies have shown developmental and individual differences to be important. Although these studies have found the more customary adverse effect of rewards on intrinsic interest and performance, they have also shown that rewards had no effect on the intrinsic interest of children whose interest was initially low (Danner & Lonky, 1981). Further, rewards have been shown to enhance the intrinsic interest and performance of young children whose initial interest was low (McLoyd, 1979; Loveland & Olley, 1979). Also material (monetary) rewards have been shown to enhance the interest and performance of kindergarten children (Sarafino & Stinger, 1981). So, the

observed reward facilitation of performance by the present nursery school children on the heuristic subscales may prove to be a reliable finding.

If that is the case, it would appear that the regression interpretation, in order to remain tenable at the level of young children, would have to be based on a developmental model similar to that espoused by Werner (e.g., 1948) in which development proceeds from a diffuse to more differentiated state, and toward greater hierarchic integration and organization. From such a perspective, regression could be expected to lead to a more global and undifferentiated level of development and perceptual organization, which, in turn, should operate to facilitate performance on heuristic tasks, possibly at the expense of impairing performance on algorithmic tasks. While this interpretation may be interesting, as well as being able to handle the present nursery school data within the regression framework, it logically could be applied only in the case of young children. Arguments related to a return to a more diffuse level of organization would seem most applicable to children who are near that point in development where they are shifting from a predominantly stimulus-response to a more cognitive mode of functioning, e.g., the sort of developmental transition that White (1965) has argued occurs in the age range from five to seven years.

This does not mean, of course, that a regression interpretation could not be applied at higher developmental levels to explain observed detrimental effects of rewards on interest and performance, but the underlying mechanism would have to be different. For example, in the case of older children and adults, reward-produced regression leading to a more primitive level of organization and functioning might lead to poorer performance and lowered interest as a consequence of changes in perceived task difficulty (e.g., Harter, 1978). That is, any task that is at an optimal level of difficulty to be intrinsically

motivating (see, e.g., Deci, 1975), should be shifted to some non-optimal and more difficult level as a consequence of any reduction in developmental organization and functioning produced by rewards. The critical issue at any age level, of course, is whether the effects of reward on performance can be better understood when viewed from the perspective of a more primitive level of development.

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Footnotes

[1]McGraw (1978) has proposed a two-factor model that makes use of the subject's initial perception of the task (attractive-aversive dimension) and the nature of the task itself (algorithmic-heuristic dimension) to predict the effects of reward on performance in a variety of situations. Algorithmic tasks allow utilization of rather well-known, mechanical solution strategies; heuristic tasks, on the other hand, require discovery and insight. A detrimental effect of reward is predicted to occur only when a task is both attractive (intrinsically motivating) and heuristic. On tasks that are either aversive or algorithmic, or both, reward is predicted to facilitate performance.

Table 1

Mean Scaled Scores (and Standard Deviations)

on the Algorithmic and Heuristic Subscales

by Age and Condition

Age	Subscales: Algorithmic			Heuristic		
	I	A	DS[a]	S	BD	OA[b]
College						
Nonreward	11.12 (2.16)	10.94 (3.11)	10.94 (2.84)	11.50 (2.00)	12.81 (2.54)	11.94 (2.82)
Reward	11.06 (1.69)	11.31 (2.36)	12.31 (2.47)	11.06 (1.48)	11.25 (1.69)	10.38 (1.89
Elementary						
Nonreward	11.50 (2.88)	10.68 (2.12)	10.88 (2.03)	11.88 (3.10)	10.38 (2.49)	12.31 (2.85)
Reward	10.50 (2.31)	9.88 (3.05)	10.44 (2.03)	12.06 (3.53)	10.94 (2.38)	10.94 (2.64)
Nursery						
Nonreward	12.44 (2.06)	12.69 (2.02)	12.75 (2.70)	11.50 (1.71)	11.06 (2.41)	11.06 (2.86)
Reward	11.94 (3.15)	11.56 (3.29)	12.44 (2.66)	11.88 (3.36)	12.31 (2.52)	11.62 (3.03)

[a]Indicates scores for Digit Symbol, Coding, and Animal House subtests.

[b]Indicates scores for Object Assembly and Geometric Design subtests.

Table 2.

Mean Scores (and Standard Devisions)

on the Algorithmic and Heuristic Tasks

as a Whole by Age, Condition and Ability Level

	Higher Ability		Lower Ability	
Age	Algorithmic	Heuristic	Algorithmic	Heuristic
College				
Nonreward	36.25 (4.23)	38.25 (5.04)	29.75 (3.77)	34.25 (5.60)
Reward	33.88 (1.81)	33.75 (3.15)	35.50 (4.34)	31.62 (2.56)
Elementary				
Nonreward	35.25 (3.62)	37.62 (2.77)	30.38 (6.59)	32.00 (6.61)
Reward	30.88 (6.22)	38.38 (5.34)	30.25 (5.09)	29.50 (6.55)
Nursery				
Nonreward	38.75 (4.20)	34.12 (6.12)	37.00 (5.15)	33.12 (2.17)
Reward	36.88 (10.02)	36.50 (5.63)	35.00 (5.71)	35.12 (6.06)